



**Australian Government**

**Department of the  
Environment and Heritage**  
National Oceans Office

# **A survey of intertidal seagrass from Van Diemen Gulf to Castlereagh Bay, Northern Territory, and from Gove to Horn Island, Queensland**

Report to the National Oceans Office

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## **Disclaimer**

Information contained in this publication is provided as general advice only. For application to specific circumstances, professional advice should be sought. Information presented in seagrass maps in this report should be read in conjunction with the original GIS database maintained at the Northern Fisheries Centre, Cairns.

The Department of Primary Industries & Fisheries, Queensland has taken all reasonable steps to ensure the information contained in this publication is accurate at the time of the survey. Seagrass distribution and abundance can change seasonally and between years, and readers should ensure that they make appropriate enquires to determine whether new information is available on the particular subject matter.

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## Summary

The distribution, structure and composition of intertidal and shallow sub-tidal seagrass communities from an area representing almost 10% of Australia's mainland coastline are described in this report. Using a combination of helicopter survey techniques and sophisticated GPS systems, a joint Queensland/Northern Territory government team of seagrass scientists mapped intertidal seagrass meadows in coastal areas between eastern Van Diemen Gulf in the Northern Territory, and Horn Island in North Queensland. The information provided by this survey addresses a gap in biological knowledge identified as being important to northern marine regional planning processes. A Geographic Information System of the seagrass distribution layers is provided.

Seven seagrass species were recorded during the survey: *Halodule uninervis*, *Syringodium isoetifolium*, *Thalassodendron ciliatum*, *Enhalus acoroides*, *Halophila decipiens*, *Halophila ovalis*, and *Thalassia hemprichii*. *Halodule uninervis* and *Halophila ovalis* were by far the most common on the open sand and mud flats. *Thalassia hemprichii* and *Thalassodendron ciliatum* were found on reef platforms and around rocky islands.

*Cymodocea rotundata*, *Cymodocea serrulata* and *Halophila spinulosa* have been recorded in shallow sub-tidal waters in this region previously and *Zostera capricorni* has been recorded from Horn Island. These species were not seen in the present survey.

An area of just over 42,000 hectares of intertidal seagrass was mapped. Combined with data from previous surveys it is estimated that at least 70,000 hectares of intertidal and shallow sub-tidal seagrass are present in the survey region. The seagrass meadows are extremely patchy in their distribution and in their individual meadow structure. The seagrass meadows we mapped are similar to most of the historical seagrass data for the region however there are some differences. We suggest that these differences are due to the survey methods used and/or because of physical damage by tropical storms and cyclones for which the region is prone.

Almost all seagrass meadows observed showed evidence of turtle activity and/or dugong feeding. Some small patches were heavily grazed and may be vital for dugong travelling along the coast.

Seagrass and algae meadows have been rated the third most valuable ecosystem globally (on per hectare basis) for ecosystem services, behind only estuaries and swamp/flood-plains. The northern Australian seagrasses are extremely important and it is essential to understand, and to measure and monitor the parameters that control their distribution and abundance. The greatest threats of loss of seagrass in this area are likely to be from climate events or climate change. This report provides only a snapshot in time of the seagrass communities. Longer-term monitoring and seasonal comparisons would be desirable to better understand the dynamics of the distribution observed.

As part of this survey, the location of discarded fishing net and discarded or apparently abandoned crab traps were recorded. Large numbers of net pieces were identified despite the likelihood that the survey techniques, designed to map seagrass, almost certainly missed a large proportion. The density of observations was clumped with an area in the western Gulf and area to the north of Aurukun with high densities of beached net pieces. Large numbers of abandoned crab traps were recorded in the south western Gulf. Net and trap type and location are recorded in a Geographic Information System layer.

## Introduction

### Project brief

This project was a joint tender to the National Oceans Office (NOO) by the Queensland Department of Primary Industries & Fisheries, the CRC Reef Research Centre and the Biodiversity Unit Natural Systems Division of the Department of Infrastructure, Planning and Environment, Northern Territory

The key aims of the project were to provide:

- A) A map in a GIS format of fine scale information on seagrass distribution and abundance between eastern Van Diemen Gulf and Castlereagh Bay, NT,
- B) A map in a GIS format of broad scale information on intertidal seagrass habitat distribution along the Gulf of Carpentaria coast between Gove and Horn Island.
- C) A map in GIS format indicating locations of discarded fishing nets.

The project provides preliminary information on the knowledge gaps in seagrass distribution as identified in the National Oceans Office key species report ([http://www.oceans.gov.au/Key\\_Species\\_North.jsp](http://www.oceans.gov.au/Key_Species_North.jsp)). It provides maps of intertidal seagrass habitat distribution, maps of discarded fishing gear and a summary report of seagrass habitat for the Northern Territory and Gulf of Carpentaria coasts. GIS detail and metadata are included on the accompanying CD Rom.

The National Oceans Office and Parks Australia have also funded a research voyage in Van Diemen Gulf/Arnhem Land for late 2004 conducted by Museum & Art Gallery of the Northern Territory and Department of Infrastructure, Planning & Environment researchers with support from the Northern Land Council, Traditional Owners and Indigenous sea ranger groups. Results from that survey will provide broad scale, general information on sub-tidal seagrass and will be reported on separately the intertidal data in the present report. Helicopter based seagrass survey techniques have been used very successfully by Queensland Department of Primary Industries and Fisheries (DPI&F) researchers to map and estimate the abundance of intertidal seagrass habitat in tropical Queensland Ports (Rasheed et al. 2001, Roelofs et al. 2001, Rasheed et al. 2003). The application of the techniques developed by these researchers is appropriate for mapping the intertidal habitats and developing a baseline dataset for the region.

This report documents the results of a fine scale helicopter survey of intertidal seagrass habitat undertaken in conjunction with the research voyage by NT DIPE and drawing on the technical expertise of the Marine Ecology Group, DPI&F, Northern Fisheries Centre. The fine scale survey includes parts of the Northern Territory coastline between the Wildman River – East Alligator River (Van Diemen Gulf) and Goulburn Islands – Woolen River (just west of Galiwinku, Elcho Island). It also includes the results of a broad scale helicopter based survey, conducted immediately following the fine scale survey that mapped seagrass habitats between Gove and Horn Island. This broad scale survey provides a data platform for designing future finer scale surveys and will assist with the regional marine planning process. The survey area is detailed in Figure 2. The survey focused on Australian mainland intertidal coastal seagrasses and, other than the Goulburn Islands; only inshore-island groups in the region were surveyed. The Cobourg Peninsula was not surveyed for this report.

## Background

The lack of reliable information on the distribution of seagrass in the tropical region from the Gulf of Carpentaria to north Western Australia was identified by Butler and Jernakoff (1999) in their review of seagrass research in Australia. In compiling maps for the World Atlas of Seagrass (Green & Short 2003) the authors used information based on anecdotal evidence from the 1970s (Williams et al. 2000), maps from CSIRO (Poiner et al. 1987) surveyed from fixed wing aircraft in the 1980s and maps from Coles and Lee Long (1985) and Coles et al. (2001) all based on late 1980 surveys. This represents the best information available however the age and methods of collection of this data make it of only indicative use in planning. More recent information is available but only for specific locations where impacts have occurred through coastal development typically within ports (Rasheed et al. 2001, Roelofs et al. 2001, Rasheed et al. 2003, Roelofs et al. 2003)

The National Oceans Office as part of its Northern Regional Planning Process required more detailed seagrass information particularly from Northern Territory waters where very little previous data were available. The reasons the region has been poorly surveyed remain. The water is often turbid and tropical north Australia is often cloudy during times of the year when suitable low tides occur making identifying seagrass from satellite imagery difficult. Tide range is large, 2.0 to 6.0 metres. The area is also remote from the nearest research facilities in Cairns and Darwin and population centres and support services generally making grounding truthing difficult and expensive.

## Tropical seagrasses

Seagrasses are specialized marine flowering plants that have adapted to the near shore environment of most of the world's continents. Most are entirely marine although some species cannot reproduce unless emergent at low tide. Some seagrasses can survive in a range of salinity conditions encompassing fresh water, estuarine, marine, or hypersaline. There are relatively few species globally (about 60) and these are grouped into just 13 genera and 5 families. Seagrasses are the main diet of dugongs and green turtles and are habitat for many, much smaller marine animals, some of which, like prawns and fish, are commercially important. They also absorb nutrients from coastal run-off and stabilise sediment, helping to keep the water clear.

Seagrass distribution has been described for most species (den Hartog 1970, Phillips and Menez 1988, Mukai 1993, Green and Short 2003). There is now a broad understanding of the global range of species and seagrass habitats. Areas where the global distribution is less well known include the Pacific Ocean reefs and islands, South America, the southern Atlantic, the Indian Ocean islands, the west African coast, and Antarctica.

Australian seagrasses species distribution is well documented except for the northern tropical region from the Gulf of Carpentaria to north Western Australia (Butler and Jernakoff 1999). Recent initiatives such as the CRC Torres Strait and port monitoring programs (eg Rasheed et al. 2001, Roelofs et al. 2003) are addressing this for restricted areas but until the present survey the majority of the north of Australia west of Cape York Peninsula lacks recent seagrass distribution data.

The importance of seagrass meadows as structural components of coastal ecosystems has resulted in new research interest being focused on the biology and ecology of seagrasses and on the methods for mapping, monitoring and protection of critical seagrass habitats. Better underwater camera systems, remote sensing, GPS positioning, and methods of measuring seagrass health such as PAM fluorometry, have improved our ability to map and monitor seagrass communities.

## Biology of tropical seagrass

Seagrasses are a unique example of how plants can adapt to new environments by living and thriving in the submerged marine environment. Seagrasses grow like backyard grasses with roots, leaves and rhizomes (horizontal underground stems that form extensive networks below the surface) but are not true grasses and are more closely related to water lilies and terrestrial plants such as lilies.

Algae are often confused with seagrass and are also plants that have colonised the sea. However, in contrast to seagrass, algae do not have a true root system (they have holdfasts) and do not have veins that carry vital molecules around the plant. Algae have spores and do not flower or produce fruit, while seagrasses have seeds and fruit.

Seagrasses are commonly found in estuaries on tidal mudflats, on shallow sandy areas close to the coast, in coral reef lagoons and around sand cays. Seagrasses also grow on the deep sandy areas of the Great Barrier Reef lagoon between the mainland and the reefs where, in clear waters, they can grow as deep as 60 metres.

In Australia, seagrasses grow in temperate and tropical waters, from the Torres Strait to southern Tasmania. In Queensland, the greatest number of species of seagrass is found near the tip of Cape York with a gradual decline in number of species moving south down the east coast. There is a transition from subtropical to temperate seagrasses south of Moreton Bay in southern Queensland.

The distribution and abundance of tropical seagrass meadows can vary with seasons. In most years, Queensland seagrasses are abundant in late October through to December, after months of clear skies, increasing day length and rising temperature, provide optimal growth conditions.

Summer rainfall and tropical cyclones and storms can produce flows of sediment-laden freshwater which can damage seagrass meadows temporarily. However, these flows also replenish the nutrients that support plant growth. Grazers such as dugongs, green turtles and some fish are also important in structuring Queensland seagrass communities, which change in space and time when disturbed. There is little known about the longer-term cycles of seagrass abundance and distribution.

Seagrass can reproduce through sexual or asexual methods. In sexual reproduction, the plants produce flowers and transfer pollen from the male flower to the ovary of the female flower. Most seagrass species produce flowers of a single sex on each individual, so there are separate male and female plants. A few seagrass species complete their lifecycle within a single year. These “annuals” produce seeds that can remain dormant for several months creating large ‘seed banks’ that ensure survival of the species until the arrival of conditions that stimulate their germination.

Seagrasses can also grow by vegetative or asexual reproduction. New ‘plants’ arise without the need for flowering or setting seed. Seagrasses grow vegetatively by extending and branching their rhizomes in the same way that grass in a lawn grows. This rhizome extension allows significant areas of seagrass meadow to form from only a few shoots. This type of growth enables seagrasses to recover after being ‘cut’ by grazers such as dugongs or after disturbance from storms. The growth of seagrass after these events is critical to their survival. If all plants of a meadow are lost then a seagrass meadow must have seeds available before it can recover. The ability of seagrass beds to recover will depend on the species of seagrass.

## Seagrasses of the Northern Planning Area

There are at least 15 species of seagrass in tropical north Australia. Species of seagrass are usually identified by the shape of their leaves, the pattern of veins on the leaves, and how the leaves attach to the rhizome. Seagrass can have a variety of leaf shapes including small oval leaves, fern-like leaves and strappy blades that can grow over 1.5 metres long.

The 15 species of seagrass recorded in the past from the Planning Area are:

### Family **CYMODOCEACEAE** Taylor

*Cymodocea rotundata* Ehrenb. & Hemp. Ex Aschers

*Cymodocea serrulata* (R. Br.) Aschers. & Magnus

*Halodule uninervis* (wide- & narrow-leaf) (Forsk.) Aschers.

*Halodule pinifolia* (Miki) den Hartog

*Syringodium isoetifolium* (Aschers.) Dandy

*Thalassodendron ciliatum* (Forsk.) den Hartog

### Family **HYDROCHARITACEAE** Jussieu

*Enhalus acoroides* (L. f) Royle

*Halophila decipiens* Ostenfeld

*Halophila minor* (Zollinger) den Hartog

*Halophila ovalis* (R. Br.) Hook f.

*Halophila spinulosa* (R. Br.) Aschers. in Neumayer

*Halophila tricostata* (Greenway)

*Halophila ovata* Gaudichaud \*\*

*Thalassia hemprichii* (Ehrenb.) Aschers in Petermann





### Family **ZOSTERACEAE** Drummortier





*Zostera capricorni* Aschers





\*\*Taxonomic revision now indicates this species is not present. Recent taxonomic revisions consider *H ovata* in the tropical Indo-western Pacific region to be a mis-identification of *Halophila minor*. The two species are not considered to co-occur in the same region (Kuo 2000).

A simple identification chart is provided in Figure 1



	<p><b><i>Cymodocea rotundata</i></b></p> <ul style="list-style-type: none"> <li>• Leaves are, flat and strap-like, but can be slightly curved</li> <li>• Leaves 2-4mm wide</li> <li>• Rounded, smooth leaf tip which can look heart-shaped</li> <li>• Smooth rhizome</li> <li>• Leaf sheath can be pale purple</li> <li>• Scars from leaf sheaths form a continuous ring around the shoot</li> </ul>
	<p><b><i>Cymodocea serrulata</i></b></p> <ul style="list-style-type: none"> <li>• Linear, strap-like leaves</li> <li>• Wider leaves than <i>Cymodocea rotundata</i></li> <li>• The leaf tip appears serrated to the naked eye</li> <li>• Leaf sheath scars do not form a continuous ring around the shoot</li> <li>• Smooth rhizome</li> </ul>
	<p><b><i>Enhalus acoroides</i></b></p> <ul style="list-style-type: none"> <li>• Very distinctive seagrass</li> <li>• Very long, ribbon-like leaves (30-150cm long, 1.25 –1.75cm wide)</li> <li>• Thick leaves with many parallel veins</li> <li>• Very thick rhizome (at least 1cm) with black, fibrous bristles</li> </ul>
	<p><b><i>Halodule pinifolia</i></b></p> <ul style="list-style-type: none"> <li>• Fine, rather delicate seagrass</li> <li>• Different plants may have leaves between 0.25 - 1mm wide</li> <li>• Leaves up to 20cm long</li> <li>• Black central vein splits into two at the leaf tip</li> <li>• Well-developed leaf sheath</li> <li>• Thin rhizome with fine thin roots</li> <li>• Dugong preferred food</li> </ul>

	<p><b><i>Halodule uninervis</i></b></p> <ul style="list-style-type: none"> <li>• Usually larger than <i>Halodule pinifolia</i></li> <li>• Narrow leaf blades 0.25-5mm wide</li> <li>• Trident leaf tip ending in three points</li> <li>• 1 central longitudinal vein which does not usually split into two at the tip</li> <li>• Usually pale ivory rhizome, with clean black leaf scars along the stem</li> <li>• Dugong preferred food</li> </ul>
	<p><b><i>Halophila decipiens</i></b></p> <ul style="list-style-type: none"> <li>• Small oval shaped leaves which occur in pairs</li> <li>• Leaves are usually longer than wide</li> <li>• Leaves are hairy and translucent</li> <li>• Leaves have serrated edges</li> </ul>
	<p><b><i>Halophila minor</i></b></p> <ul style="list-style-type: none"> <li>• Small oval shaped leaves</li> <li>• Central vein on leaf with cross-veins</li> <li>• Leaves in pairs from rhizome</li> <li>• Wedge-shaped leaf sheath</li> </ul>
	<p><b><i>Halophila ovalis</i></b></p> <ul style="list-style-type: none"> <li>• Small oval shaped leaves (0.5 - 2cm long)</li> <li>• 8 or more cross-veins on leaf</li> <li>• No hairs on leaf surface</li> <li>• Dugong preferred food</li> </ul>

	<p><b><i>Halophila spinulosa</i></b></p> <ul style="list-style-type: none"> <li>• Shoots can be up to 15cm long</li> <li>• 10-20 pairs of leaflets per shoot</li> <li>• Each leaflet arranged in opposite pairs</li> <li>• Each leaflet is 1.5-2.5cm long and 3–5mm wide</li> <li>• Leaflets have a serrated edge</li> <li>• Thin rhizomes</li> </ul>
	<p><b><i>Halophila tricostata</i></b></p> <ul style="list-style-type: none"> <li>• Shoots can be 8-18cm long</li> <li>• 6-18 groups of leaflets per shoot</li> <li>• Leaflets clustered in groups of 2-3</li> <li>• Each leaflet is 1.2-2.0cm long and 2–4mm wide</li> <li>• Leaflets have a sparsely serrated edge</li> <li>• Wedge-shaped leaf sheath</li> <li>• Thin rhizome</li> </ul>
	<p><b><i>Syringodium isoetifolium</i></b></p> <ul style="list-style-type: none"> <li>• Narrow, round, thin leaves (1-2mm diameter)</li> <li>• Leaves 7-30cm long</li> <li>• 2-3 leaves arising at each shoot</li> <li>• Long leaf sheaths 1.5-4.0cm long</li> <li>• Thin rhizomes</li> </ul>
	<p><b><i>Thalassia hemprichii</i></b></p> <ul style="list-style-type: none"> <li>• Long, ribbon-like leaves 10-40cm long</li> <li>• 10-17 longitudinal leaf veins</li> <li>• Short black bars of tannin cells on leaf blade</li> <li>• Leaf sheaths 3-7cm long</li> <li>• Thick rhizome (up to 5mm) with conspicuous scars between shoots</li> </ul>



	<p><b><i>Thalassodendron ciliatum</i></b></p> <ul style="list-style-type: none"><li>• Distinctive seagrass</li><li>• Cluster of ribbon-like curved leaves at the end of a long shoot</li><li>• Leaves 10-15cm long and 0.5-1.4cm wide</li><li>• Tough, woody rhizomes with scars from successive shoots</li><li>• Very coiled, branched roots</li><li>• Found only in the Torres Strait in the study area</li></ul>
	<p><b><i>Zostera capricorni</i></b></p> <ul style="list-style-type: none"><li>• Narrow, wide leaf blades</li><li>• 5 longitudinal veins</li><li>• Cross veins which form a mesh across the leaf blade</li><li>• Rounded leaf tip</li><li>• Leaf grows straight from the rhizome ie no shoots</li><li>• Fibrous root system</li><li>• Provide nursery grounds for juvenile prawns</li><li>• Found only in the Torres Strait in the study area</li></ul>

Figure 1 Species of seagrass found in tropical Queensland and Northern Territory

## Study Area

Coastal Northern Territory lies within the wet-dry tropics of northern Australia. It is characterised by a tropical monsoon with a distinct wet season starting in November/December and lasting for approximately four months followed by a dry season. The mean annual rainfall for Jabiru, and the Goulburn-Millingimbi region is 1485 and 1200 mm respectively. Average maximum air temperatures for Jabiru, and the Goulburn-Millingimbi region ranges between 31-38 and 29–34 °C respectively, with the hottest month being November and the coolest month July. The average minimum air temperature for both regions ranges between 18–25 °C. The prevailing winds are seasonal with south-east winds during the dry season and north-west monsoons during the wet season. Cyclonic activity is low to moderate (Ferns 1999).

Local indigenous people hold much of the biological knowledge of the area. Very little marine research has been conducted and consequently there is very little known about the distribution and abundance of marine flora and fauna, including seagrasses. Seagrass has been reported in the past from Nhulunbuy (*Halophila decipiens*) and along the north coast of the Tiwi Islands. Apart from anecdotal evidence, such as information from the local indigenous people who have indicated where they hunt turtle and dugong and from aerial dugong surveys there have been no systematic studies of seagrass meadows along the western part of the north Arnhem Land and Van Diemen Gulf coastline.

## Van Diemen Gulf

The Van Diemen Gulf is a large, almost fully enclosed, body of water located approximately 100 km east of Darwin. It has narrow openings to the north (Dundas Strait) and southwest (Clarence Strait). Water depths vary up to 100 m deep in the Dundas Strait, but are generally less than 30 m with the southern and eastern margin forming a broad shallow shelf (less than 10 m depth). Small islands (eg Field and Baron Islands) and reefs are scattered across this shelf, in particular along the southeastern and eastern side.

Mainland landforms along the southern coast are dominated by extensive low, flat, estuarine, coastal plains fringed at the coast by mud flats/banks often associated with a narrow band of mangroves. Within the Kakadu region, two large rivers (the South and East Alligator Rivers) and two smaller rivers (West Alligator and Wildman Rivers) create large floodplains during the wet. The rivers are typical tide dominated rivers with intertidal flats, mangroves and saline flats/salt marshes with a naturally high turbidity.

Field Island, located in the mouth of the South Alligator River, is characterised by intermittent fringing reefs with extensive sand flats and an occasional beach along the eastern and northern side. The western side is dominated by mangroves and mudflats.

The extent of the seagrass survey in this area was limited to the intertidal waters adjacent to Kakadu National Park in the south east corner of the Van Diemen Gulf. The survey covered approximately 100 km of intertidal coastline, including two small islands: Field Island and Baron Island. This part of the coastline is very sheltered except during the wet season when northwest monsoon winds dominate.

## Goulburn Islands - Castlereagh Bay

This region encompasses the western coastline of northern Arnhem Land and lies within the western part of the Arnhem-Wessel marine bioregion (ANZECC 1998). The Goulburn-Castlereagh Bay region has a diverse coastline. Between Goulburn Islands and Maningrida the dominant landforms are undulating sand and lateritic plains with sandy beaches and low rocky headlands with mangrove lined saline mudflats in the more protected bays and estuaries. East of Maningrida, coastal landforms are dominated by floodplains and mangroves with extensive tidal mud and sand flats. Off the coast there are a number of islands: North and South Goulburn islands; Entrance Island in the mouth of the Liverpool estuary; Mooroonga Island and the Crocodile Islands, which lie north-east of Millingimbi.

The major rivers of this region are the King, Goomadeer, Liverpool, Blythe and Goyder rivers and all have a moderate freshwater output (eg the minimum end of dry-season flow rate for the Goyder River is 1.8 cumecs (cubic meters per second), whilst peak wet-season flow is at least 200 cumecs) (Brennan et al. 2004).

In this area the coastal waters are shallow and have a tidal range of 2 - 5 m (Heap et al. 2004). Currents (0.5 – 1.0 knots) are generally westerly during the Dry but during the Wet they are weak and have no constant direction (Heap et al. 2004). Wave energy is generally low except during short periods during storm and cyclonic activity in the Wet and transition periods between the Wet and Dry (Davies 1986). Water clarity varies within the region: estuaries, protected bays in the west and near coastal waters in the east are naturally turbid, whereas the rocky platform and sandy areas in the west and offshore waters across the region including around the offshore islands (eg Goulburn's, Crocodile and Mooroonga islands) have low turbidity.

## Gulf of Carpentaria and Torres Strait

The Gulf of Carpentaria is a large, shallow, muddy marine bay located in northern Australia between 10 ° South and 17.5 ° South and 136 ° – 142 ° East. The area has marked seasonality in temperature, rainfall, salinity and wind regimes. The dominant weather feature is a seasonal summer monsoon with associated northerly winds and rain and a very dry winter period with south-east trade winds. Seasonal temperatures range from 10 °C in winter (Poiner et al. 1989) to the high 30's in summer. Tidal ranges are from 3.3m in Weipa, 5.1m in Karumba down to 0.5m at Groote Eylandt.

The Gulf has a diversity of land forms including offshore islands, fringing coral reefs, sandy, muddy and cliff-lined coastal topographies as well as extensive tidal mud/sand flats (Poiner et al 1989). Extensive open coastline seagrass communities have been reported in the southern Gulf in the past, mainly of the genera *Halodule* and *Halophila* intertidally, and *Syringodium* and *Cymodocea* sub-tidally. Along the exposed eastern coast of the Gulf, seagrasses are generally sparse and restricted to the lee side of islands, protected reef flats, and estuaries and protected bays (Coles et al. 2001). The coastline of the eastern Gulf is shallow and regularly disturbed by prevailing winds.

Previous broad scale surveys have been conducted of the western Gulf of Carpentaria coast (Poiner et al 1989). This is a complex coastline with few river inputs, and is consequently less muddy than the southern Gulf.

Sediments throughout the Gulf are predominantly fine muds, and these are easily resuspended due to the shallow bathymetry resulting in increased turbidity, which restricts

seagrass distribution and growth. Cyclones and storms also readily disturb and shift sediments in this shallow environment and seagrass distribution may be influenced by a history of past storm events. Where seagrass occur on reef platforms they are dominated by *Thalassia*. Meadows in estuaries and sheltered bays are mostly of the genera *Halodule*, with *Cymodocea* and *Enhalus*.

## Methodology

### Study plan

The fine scale helicopter survey of intertidal habitats between Van Diemen Gulf and Castlereagh Bay, Northern Territory was conducted between November 13 and 17, 2004 (Table 1). The broad scale helicopter based survey from Gove to the Torres Strait was completed between 17 and 20 November 2004. Dates for the survey were selected based on suitable low tides.

The fine scale survey was designed to provide detailed information on seagrass distribution and abundance (to species level) in the intertidal regions from eastern Van Diemen Gulf to Castlereagh Bay. The broad scale survey provides information on intertidal seagrass presence/absence, species distribution and cover at a lower scale and resolution for the NT and Qld Gulf of Carpentaria coastline. The survey area is detailed in Figure 2.

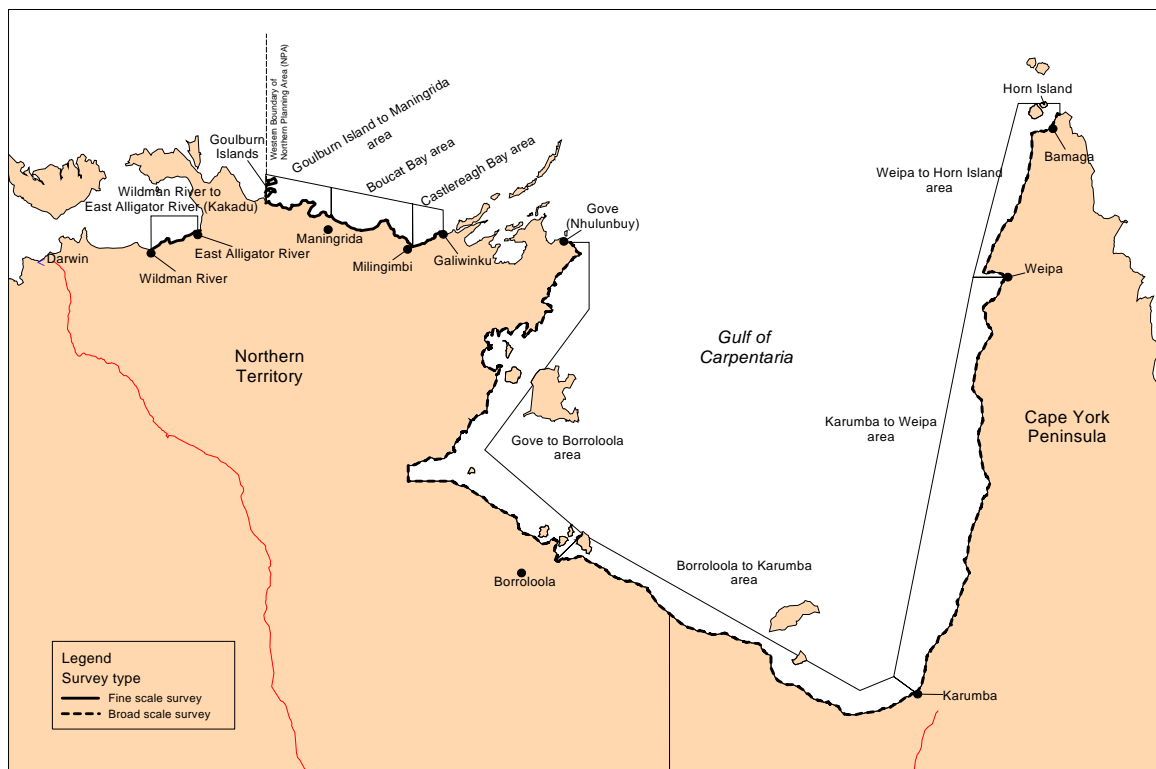


Figure 2 Map of study area

Survey methods were based on helicopter seagrass survey techniques developed by the Marine Ecology Group, DPI&F, for surveys in the Ports of Weipa, Karumba and Thursday Island (see Rasheed et al. 2001, Roelofs et al. 2001, Rasheed et al. 2003). The technique uses visual mapping from a helicopter at no higher than 300 feet travelling at approximately 70 knots or slower where required. Presence of seagrass is confirmed by

circling to land or to hover close to the ground at sites chosen haphazardly with specimen collection if required for taxonomy. Two observers independently recorded the presence of seagrass. Waypoints and track were logged electronically by each observer and comments entered on a chart. A video and digital photo record of key sites and representative habitat was made. A qualitative assessment was made of seagrass cover and patchiness (see Figure 4). Seagrass community types were categorised according to the seagrass species, or combination of species, that dominated the overall composition of each meadow (Table 2).

Data from the survey was entered onto an ArcGIS® and Mapinfo® based Geographic Information System.

Table 1 Seagrass habitat mapping project sampling timetable.

Dates (2004)	Survey area
13 – 16 Nov	<p><b>Kakadu to Castlereagh Bay fine scale seagrass survey work</b></p> <ul style="list-style-type: none"> <li>• 13 Nov – Kakadu (overnight at Kakadu)</li> <li>• 14 Nov – Goulburn Is to Maningrida (overnight at Maningrida)</li> <li>• 15 Nov – Maningrida to Milingimbi (overnight at Milingimbi)</li> <li>• 16 Nov – Castlereagh Bay (overnight at Gove)</li> </ul>
17 – 20 Nov	<p><b>Gove to Torres Strait broad scale seagrass survey</b></p> <ul style="list-style-type: none"> <li>• 17 Nov – Gove to Borroloola</li> <li>• 18 Nov – Borroloola to Karumba</li> <li>• 19 Nov – Karumba to Weipa</li> <li>• 20 Nov – Weipa to Horn Is</li> </ul>

### Consultation with traditional owners

In recognition of Aboriginal people's ownership and management responsibilities for land in the survey region, the development and planning of the aerial seagrass survey included extensive consultation with Indigenous communities, organisations and Traditional Owners. Without their help and guidance this survey could not have taken place.

Consultation was primarily conducted through the parallel program, the Northern Australian Marine Biodiversity Survey (NAMBS), to which the Northern Land Council (NLC) was a collaborative partner.

The NLC led the development and organisation of the consultation process which consisted of:

- distribution by fax of communiqués describing the NAMBS to the Ramingining Homeland Centre, Milingimbi Community Council, Bawinanga Aboriginal Corporation, Delk Rangers, Warruwi Community Council, Marbalk rangers, Galiwinku
- letters to traditional Aboriginal owners in the survey area to inform them of upcoming consultations in their communities regarding the NAMBS



- distribution by fax of communiqués detailing the aerial survey plan to the groups and communities above as well as to the Wanga Djakamirri rangers (Laynhapuy homelands), Yugal Mangi Landcare (Ngukurr), Dhimurru Land Management Aboriginal Corporation, Mabunji Sea ranger group (Borrooloola) (Appendix 1), and Numbulwar Homelands;
- cross cultural training for vessel crew and research staff,
- presentations at general community and council meetings (Bawinanga, Milingimbi, Crocker and Waruwi), and
- a consultation trip undertaken during September 2004 by NTG, NLC and NOO staff to meet with Traditional Owners in the survey area. This consultation trip proved to be enormously helpful in establishing direct contact between Traditional Owners and research staff, and enabling direct feedback by Traditional Owners to the survey planning and development. The consultations also provided an important opportunity for researchers to work with coastal communities in identifying known seagrass meadows for further investigation (Figure 3), as well as identifying areas of significance to Traditional Owners that needed to be avoided during survey work. This consultation trip also identified who would be involved in the surveys from the communities and the protocols in terms of return of information, and acknowledgement and use of traditional knowledge.

A communiqué detailing the aerial survey was also distributed throughout the Queensland portion of the GOC and western Cape York communities via the Aboriginal Councils of Cape York, Cape York Land Council/Balkanu Corporation, Carpentaria Land Council, Cape York Land and Sea Centres, Natural Heritage Trust Natural Resource Management Groups, Torres Strait Regional Authority, Cape York Peninsula Development Association, Mitchell River Catchment Group, SeaNet, Ecofish, and the Gulf of Carpentaria Commercial Fisherman's Association.



Figure 3 Maps resulting from consultation trip (September 2004) between Aboriginal land owners and research staff, identifying seagrass meadows known to local Aboriginal people.

Table 2 Nomenclature for seagrass community types in the survey area.

Community type	Species composition
Species A	Species A is 100% of composition
Species A with Species B	Species A is 60% of composition
Species A with Species B/Species C	Species A is 50% of composition
Species A/Species B	Species A is 50% - 60% of composition



*Isolated seagrass patches* - The majority of area within the meadows consisted of unvegetated sediment interspersed with isolated patches of seagrass



*Aggregated seagrass patches* - Meadows comprised numerous seagrass patches but still featured substantial gaps of unvegetated sediment within the meadow boundaries



*Continuous seagrass cover* - Meadows comprised continuous seagrass cover interspersed with a few gaps of unvegetated sediment.

Figure 4 Seagrass meadow patchiness categories used in the intertidal seagrass survey – November 2004.

## Results

### Seagrass Distribution

Intertidal seagrass communities are presented in Maps 1 to 3. This survey mapped about 42 389 hectares (ha) of intertidal seagrass meadows (Table 3). Combined with mapping figures from previous seagrass surveys (Blue Mud Bay and Groote Eylandt October 1984, Mornington and Wellesley Islands – September 1984, Port Musgrave to Cape York – October 1986), our conservative estimate of the total area of seagrass meadows in the survey region is about 69 677 ha (Table 3).

Helicopter tracks and a map of sampling locations are presented in Map 4. In interpreting the maps and seagrass distribution it is essential to note that not all coastal areas were surveyed and those areas surveyed were subject to differing surveying intensities as required by the project brief. The seagrass distribution mapped for this report is for intertidal seagrasses and in most places (particularly in the Gulf of Carpentaria) restricted to the mainland coast.

Seagrass distribution in the region is very disjointed. Seagrass is not common in large open bays and is found typically in and around inshore islands, small bays and inlets. Intertidal meadows of *Halophila ovalis* and *Halophila ovalis* mixed with *Enhalus acoroides*, *Halodule uninervis*, *Thalassia hemprichii* and *Halophila decipiens* dominate.

The majority of seagrass meadows were comprised of only aggregated seagrass patches with many bare areas between the seagrass plants (Table 3). There relatively few meadows that had continuous seagrass cover although these tended to also be large meadows.

**Table 3** Meadow categories, total area (hectares) and numbers of intertidal meadows mapped for the November 2004 survey and for previous Gulf of Carpentaria surveys

Category	Area in hectares (number of meadows)			Total
	Isolated seagrass patches	Aggregated seagrass patches	Continuous seagrass cover	
<i>Enhalus acoroides</i>	276 (29)	43 (3)		320 (32)
<i>Enhalus acoroides</i> with <i>Halophila ovalis</i>		371 (1)		371 (1)
<i>Enhalus acoroides</i> with mixed species	442 (14)	1577 (11)	268 (2)	2288 (27)
<i>Halodule uninervis</i> (narrow form)	32 (2)	620 (14)	1386 (4)	2039 (20)
<i>Halodule uninervis</i> (narrow form) with <i>Enhalus acoroides</i>		113 (1)		113 (1)
<i>Halodule uninervis</i> (narrow form) with mixed species		2383 (1)		2383 (1)
<i>Halodule uninervis</i> (narrow form)/ <i>Halophila ovalis</i>	0.02 (1)	3333 (5)	195 (3)	3528 (9)
<i>Halodule uninervis</i> (narrow form)/ <i>Halophila ovalis</i> with mixed species	41 (1)	870 (5)		911 (6)
<i>Halophila decipiens</i>	19 (6)	61 (6)		80 (12)
<i>Halophila decipiens</i> with mixed species		14 (1)		14 (1)
<i>Halophila ovalis</i>	3260 (52)	12 632 (71)	361 (4)	16 254 (127)
<i>Halophila ovalis</i> with <i>Enhalus acoroides</i>	33 (1)	825 (4)		858 (5)
<i>Halophila ovalis</i> with <i>Halodule uninervis</i> (narrow form)		827 (1)		827 (1)
<i>Halophila ovalis</i> with mixed species	916 (5)	541 (2)		1457 (7)
<i>Halophila ovalis</i> with <i>Thalassia hemprichii</i>		58 (1)		58 (1)
<i>Halophila ovalis</i> / <i>Halodule uninervis</i> (narrow form)	416 (5)	9481 (34)		9897 (39)
<i>Halophila ovalis</i> / <i>Halophila decipiens</i>	0.04 (3)	3 (1)		3 (4)
<i>Thalassodendron ciliatum</i> with <i>Thalassia hemprichii</i>		185 (1)		185 (1)
<i>Thalassia hemprichii</i>		6 (5)		6 (5)
<i>Thalassia hemprichii</i> with <i>Enhalus acoroides</i>			39 (1)	39 (1)
<i>Thalassia hemprichii</i> with <i>Halophila ovalis</i>		22 (3)	227 (1)	250 (4)
<i>Thalassia hemprichii</i> with mixed species	45 (2)	45 (1)		90 (3)
<i>Thalassodendron ciliatum</i>			0.7 (1)	0.7 (1)
<i>Enhalus acoroides</i> / <i>Halodule uninervis</i> (wide form)		206 (1)		206 (1)
<i>Halodule uninervis</i> (narrow form)/ <i>Halophila decipiens</i>		22 (1)	153 (1)	175 (2)
<i>Halodule uninervis</i> (wide form)	0.9 (1)			0.9 (1)
<i>Syringodium isoetifolium</i> with mixed species	22 (1)			22 (1)
<b>Sub total</b>	<b>5507 (123)</b>	<b>34 248 (174)</b>	<b>2633 (17)</b>	<b>42 389 (314)</b>
Additional meadows mapped in region				
Blue Mud Bay and Groote Eylandt (NT) - Poiner et al. 1987				7854 (26)
Mornington and Wellesley Islands (Qld) Sept 1984 – Coles et al. 2001				11 602 (39)
Port Musgrave to Cape York (Qld) Oct 1986 – Coles et al. 2001				7832 (32)
<b>Grand Total</b>				<b>69 677 (411)</b>

## Van Diemen Gulf

The majority of intertidal seagrass meadows in the Van Diemen Gulf region of the survey were mapped on the fringing reef of Field Island (Map 1). *Halophila ovalis* dominated these meadows (Table 4). The majority of meadows in the region were comprised of aggregated seagrass patches. Only very small isolated seagrass patches were found along the mainland coastline adjacent to Kakadu National Park. Evidence of dugong feeding was found throughout the region.

Table 4 Meadow categories, total area (hectares) and number of intertidal meadows mapped in the Van Diemen Gulf region, Northern Territory - November 2004.

Category	Area in hectares (number of meadows)			Total
	Isolated seagrass patches	Aggregated seagrass patches	Continuous seagrass cover	
<i>Halodule uninervis</i> (narrow form)			0.01 (2)	0.01 (2)
<i>Halophila ovalis</i>	76 (8)	1222 (11)		1298 (19)
<i>Halophila ovalis</i> with <i>Halodule uninervis</i> (narrow form)		827 (1)		827 (1)
<b>Total</b>	<b>76 (8)</b>	<b>2050 (12)</b>	<b>0.01 (2)</b>	<b>2126 (22)</b>

## Goulburn Islands - Castlereagh Bay.

Intertidal seagrass communities in this region were concentrated around the Goulburn Islands, Maningrida and Milingimbi (Map 1, Table 5). The Goulburn Islands seagrasses were typical of tropical reefal seagrass communities and were comprised of *Thalassia*, *Thalassodendron* and *Enhalus* species. The sheltered regions near the Maningrida and Milingimbi communities supported extensive *Halophila* dominated meadows. Isolated and aggregated seagrass patches was the dominant cover type for this region.

Evidence of dugongs feeding was also found throughout the region's *Halophila* dominated seagrass meadows. The large open bays in the region (Boucaut, Castlereagh, Buckingham and Arnhem Bays) were almost devoid of intertidal seagrass meadows, with only small isolated meadows found in Castlereagh and Boucaut Bays.

## Gulf of Carpentaria (Northern Territory coast)

*Halophila* meadows were the major intertidal meadow types for this region (Map 2, Table 6). In the areas surveyed, seagrass communities were concentrated in the Caledon and Blue Mud Bay regions in the north, Numbulwar, and the Borroloola/Sir Edward Pellew Island group in the south. Previous studies have also identified significant areas of seagrass at Groote Eylandt (Poiner et al. 1987). The dominant cover type for the region was meadows with aggregated seagrass patches.

The *Halophila* meadows in Caledon Bay had particularly high dugong feeding activity, while the seagrass meadows from Limmen Bight to the Sir Edward Pellew Island Group had high numbers of feeding flatback turtles (50+ on some meadows) and several dugongs.

Table 5 Meadow categories, total area (hectares) and numbers of intertidal meadows from Goulburn Islands to Castlereagh Bay, Northern Territory - November 2004.

Category	Area in hectares (number of meadows)			Total
	Isolated seagrass patches	Aggregated seagrass patches	Continuous seagrass cover	
<i>Enhalus acoroides</i> with <i>Halophila ovalis</i>		371 (1)		371 (1)
<i>Enhalus acoroides</i> with mixed species		1256 (2)	13 (1)	1269 (3)
<i>Halodule uninervis</i> (narrow form) with <i>Enhalus acoroides</i>		113 (1)		113 (1)
<i>Halodule uninervis</i> (narrow form)/ <i>Halophila ovalis</i>			2 (1)	2 (1)
<i>Halophila decipiens</i>	13 (2)	60 (4)		73 (6)
<i>Halophila decipiens</i> with mixed species		14 (1)		14 (1)
<i>Halophila ovalis</i>	2552 (9)	584 (16)	266 (2)	3404 (27)
<i>Halophila ovalis</i> with <i>Enhalus acoroides</i>	33 (1)	825 (4)		858 (5)
<i>Halophila ovalis</i> with <i>Thalassia hemprichii</i>		58 (1)		58 (1)
<i>Halophila ovalis</i> / <i>Halophila decipiens</i>	0.04 (3)			0 (3)
<i>Thalassadendron ciliatum</i> with <i>Thalassia hemprichii</i>		185 (1)		185 (1)
<i>Thalassia hemprichii</i>		6 (5)		6 (5)
<i>Thalassia hemprichii</i> with <i>Enhalus acoroides</i>			39 (1)	39 (1)
<i>Thalassia hemprichii</i> with <i>Halophila ovalis</i>		22 (3)	227 (1)	250 (4)
<i>Thalassia hemprichii</i> with mixed species		45 (1)		45 (1)
<i>Thalassodendron ciliatum</i>			0.7 (1)	0.7 (1)
<b>Total</b>	<b>2599 (15)</b>	<b>3543 (40)</b>	<b>550 (7)</b>	<b>6694 (62)</b>

Table 6 Meadow categories, total area (hectares) and numbers of intertidal meadows mapped from Gove to the Northern Territory border - November 2004.

Category	Area in hectares (number of meadows)			Total
	Isolated seagrass patches	Aggregated seagrass patches	Continuous seagrass cover	
<i>Enhalus acoroides</i>	41 (1)	43 (3)		84 (4)
<i>Halodule uninervis</i> (narrow form)		29 (1)	436 (1)	465 (2)
<i>Halodule uninervis</i> (narrow form)/ <i>Halophila ovalis</i>			100 (1)	100 (1)
<i>Halophila decipiens</i>		0.4 (1)		0.4 (1)
<i>Halophila ovalis</i>	586 (11)	10733 (34)	13 (1)	11333 (46)
<i>Halophila ovalis</i> with mixed species		541 (2)		541 (2)
<i>Halophila ovalis</i> / <i>Halodule uninervis</i> (narrow form)	386 (3)	7496 (21)		7883 (24)
<i>Halophila ovalis</i> / <i>Halophila decipiens</i>		3 (1)		3 (1)
<b>Total</b>	<b>1014 (15)</b>	<b>18847 (63)</b>	<b>549 (3)</b>	<b>20411 (81)</b>

### Gulf of Carpentaria (Queensland coast)

The Queensland section of the Gulf of Carpentaria coastline from the Northern Territory border to Aurukun was dominated by open bare coasts, turbid water, and a few areas of extensive intertidal seagrass (Map 3, Table 7). Most meadows across the region were aggregated patches, with relatively few continuous meadows. Fringing reef areas, open sandy beaches and less turbid water was found north of Aurukun. Extensive intertidal seagrass meadows were found at Karumba, Aurukun and Weipa. Previous studies have also identified significant areas of seagrass at Mornington and Wellesley Islands, Port Musgrave and near Bamaga (Coles et al. 2001).

Table 7 Meadow categories, total area (hectares) and numbers of intertidal meadows mapped from the Northern Territory border to Bamaga, Queensland - November 2004.

CATEGORY	Area in hectares (number of meadows)			Total
	Isolated seagrass patches	Aggregated seagrass patches	Continuous seagrass cover	
<i>Enhalus acoroides</i>	235 (28)			235 (28)
<i>Enhalus acoroides</i> with mixed species	442 (14)	321 (9)	255 (1)	1018 (24)
<i>Halodule uninervis</i> (narrow form)	32 (2)	591 (13)	951 (1)	1574 (16)
<i>Halodule uninervis</i> (narrow form) with mixed species		2383 (1)		2383 (1)
<i>Halodule uninervis</i> (narrow form)/ <i>Halophila ovalis</i>	0.02 (1)	3333 (5)	93 (1)	3426 (7)
<i>Halodule uninervis</i> (narrow form)/ <i>Halophila ovalis</i> with mixed species	41 (1)	870 (5)		911 (6)
<i>Halophila decipiens</i>	5 (4)	1 (1)		6 (5)
<i>Halophila ovalis</i>	45 (24)	91 (10)	81 (1)	217 (35)
<i>Halophila ovalis</i> / <i>Halodule uninervis</i> (narrow form)	29 (2)	1984 (13)		2014 (15)
<i>Thalassia hemprichii</i> with mixed species	45 (2)			45 (2)
<i>Enhalus acoroides</i> / <i>Halodule uninervis</i> (wide form)		206 (1)		206 (1)
<i>Halodule uninervis</i> (narrow form)/ <i>Halophila decipiens</i>		22 (1)	153 (1)	175 (2)
<i>Halophila ovalis</i> with mixed species	916 (5)			916 (5)
<i>Halodule uninervis</i> (wide form)	0.9 (1)			0.9 (1)
<i>Syringodium isoetifolium</i> with mixed species	22 (1)			22 (1)
<b>Total</b>	<b>1816 (85)</b>	<b>9805 (59)</b>	<b>1534 (5)</b>	<b>13156 (149)</b>



## Discussion

The survey area represents 3350km or nearly 10% of the Australian coastline – an extremely large area and the shallow inshore waters, particularly in the Gulf of Carpentaria, sometimes extend many kilometres seaward with extensive intertidal mud/sand flats making boat surveys slow or impractical.

The approach used in this survey addresses the logistic issues of geographic scale with some compromises. Helicopter based surveying avoids overestimating seagrass by not including algae or discoloured sand allowing ground truthing and collection of specimens for taxonomy if required. The helicopter has a 50-70 knot forward speed and affords excellent visibility for the observers. Flying slowly up to 300 feet altitude is the best possible platform for mapping seagrass over such large areas.

But there are disadvantages. It is expensive and imposes a distance limit due to fuel range. With infrequent locations for refuelling and budget restrictions, the surveys in some areas of the coast line with complex inlets and structures are more superficial than we would have liked. Some areas were excluded due to these constraints, therefore it is important to read the final distributions taking the actual helicopter track into consideration. Aerial surveys are only valuable for mapping intertidal seagrass and the very shallow sub tidal. Fortunately in this region the tides are such that the survey could be conducted at a daytime low tide from Darwin through to Weipa, after that the tides were not as low as desirable (ie. Weipa to Horn Island). In the southern Gulf of Carpentaria, turbidity prevented any sub-tidal mapping along much of the coastline. Previous surveys suggest that there are small but significant bands of seagrass sub-tidally in this region and these will have been missed in the present survey. The extent of these meadows could only be determined by a boat and diver survey and the expense and time involved would be prohibitive. Previous dive surveys by Coles et al (2001) of the Queensland Gulf waters found little sub-tidal seagrass except in more northern regions where turbidity was lower.

Presenting visual hard copy maps of information from an area as large as in this report is challenging as the size of the seagrass meadows is dwarfed by the size of the survey area. Hard copy maps are a good platform to present areas of presence but are less useful at highlighting absence, particularly when not all areas in a map were visited during the survey. The maps we present highlight seagrass meadows that we observed as features, and show as coloured the areas that were not visited. Small areas of seagrass are harder to represent and it is vital to interrogate the GIS map layers for detailed planning purposes. Information from older surveys is also included in the maps but it is necessary to realise some of this is more than 20 years old. Our experience would suggest that seagrass distribution in sheltered locations does not change quickly unless damaged by a climatic event. However, given the time that has passed, and the accuracy of position fixing systems available in pre GPS times these older surveys should be treated with caution.

The suite of seagrass species found is unsurprising. *Thalassia hemprichii* and *Thalassodendron ciliatum* are normally reef top species and in this survey were found in the Goulburn Islands, near Borroloola, and in the Weipa region where there were low rocky reefs. *Enhalus acoroides* was less common than expected and was found similarly near the Goulburn Islands and in Weipa and a single large meadow in Caledon Bay. *Enhalus acoroides* is a large tropical intertidal seagrass species, easily seen and identified from the air. Apart for the Goulburn Islands, species of the genus *Cymodocea* species were absent from our survey results and *Syringodium* uncommon. However previous work (Poiner et al 1987, Coles and Lee Long 1985 and Coles et al 2001) showed that these species are present, particularly around offshore islands that were not surveyed for the present report. Dominant in the intertidal regions were *Halophila* and *Halodule* species – pioneering species that are common on mud/sand flats in the tropics and are key food species for dugong and turtle.



Patchy structure of intertidal seagrass meadows

An outstanding feature of the seagrass distribution is its patchy nature. Enormous lengths of sand/mud flats devoid of seagrass were covered only to then encounter a large meadow followed by more intertidal flats often with no obvious geographic feature to signal the change. The large meadows near Karumba are a good example of this. Seagrass meadows were often small, less than a hectare, and these patches were often heavily grazed by dugong, suggesting an importance to that species greater than the size of the patch would indicate. The patches may be essential to animals travelling along the Gulf coast.



Dugong feeding trails on a meadow of approx 100 square metres

Another meadow feature was the predominance of either isolated or aggregated seagrass patches as cover type. This is likely related to the structure of individual plants, the dynamic nature and topography of the intertidal flats, and perhaps recent regional climate conditions. Intertidal seagrass meadows monitored by DPI&F at Weipa and Karumba have shown decreases in cover over recent years (Rasheed et al. 2001, Roelofs et al. 2001, Rasheed et al. 2003, Roelofs et al. 2003). It is thought the decreases may be related to the lack of 'normal' wet season weather patterns combined with high winter daytime temperatures causing stress to intertidal seagrass plants. A recent return to more typical 2003/4 wet season in the southern Gulf corresponded with a return to historically high cover and biomass levels for Karumba's meadows (Rasheed & McKenna 2005) and tends to confirm the dependence of seagrass health on prevailing weather conditions.

On the East Gulf coast north of the Love and Kirke Rivers the seagrass distribution is restricted almost entirely to estuaries and bays and seagrass is not found in coastal waters again until near the top of Cape York (Coles et al. 2001). This poses threats for populations of dugong bringing them in close contact with human populations and into areas used for net fishing and traditional hunting.

Less seagrass was recorded than that reported by Poiner et al. (1987) but several meadows (admittedly small ones) that were not recorded by Coles et al. (2001) were found. Some of these differences may be simply due to the dissimilar methods used by each of the surveys. Coles et al. (2001) was based on a dive survey and seagrass meadows close to the mangroves would have been missed at low tide. Poiner et al. (1987) used a fixed wing aircraft and consequently may have included non-seagrass features (eg algae) as seagrass because they could not ground truth. Poiner et al. (1987) did some limited ground truthing at a later date, including sub-tidal observations, so his tabulated areas would include some sub-tidal meadows not surveyed in the present report. Poiner et al. (1987) also reported *no* seagrass in the Karumba region although it was recorded there during dive and boat surveys in 1987. It is difficult to explain all of these discrepancies with previous surveys as entirely due to changes in seagrass distribution. They are more likely mostly due to variation in method; and to changes in meadow biomass making meadows hard to see or to distinguish from sediment colour from the air.

Alternatively, some of the large scale differences in seagrass distribution recorded could represent real change over the years that may have been driven in part by natural events such as cyclones. This is especially relevant around Bing Bong where much less seagrass was recorded than Poiner et al. (1987). Cyclone activity in 2000 (cyclone Steve), 2001 (cyclones Wilsome and Abigale) and 2002 (cyclone Bernie) badly damaged seagrass meadows in the region and seagrass has only recently re-established in the area (David Parry, Northern Territory University, pers com).

Seagrass and algae meadows have been rated the third most valuable ecosystem globally (on per hectare basis) for ecosystem services, behind only estuaries and swamp/flood-plains (Costanza et al. 1997). Seagrass meadows have a well-documented role, in providing food and shelter, as nursery grounds for many animals, and as substrate stabilisers (McRoy & Helfferich 1980, Staples et al. 1985, Blaber et al. 1989, Haywood et al. 1995). Watson et al. (1993) working with three species of penaeid shrimp have provided a direct value for tropical Australian seagrasses to the commercial penaeid shrimp fishery of an average of approximately 1400 dollars (AUD\$) per year for each hectare of seagrass. If this value were translated to seagrass in this survey the annual value of these commercial shrimps alone would be 59 million dollars (AUD\$).



*Halophila ovalis* near Kowanyama in Queensland waters

The dominant species found are also key food species for turtles and dugong. Almost all seagrass meadows observed in this survey had dugong feeding trails and turtles were observed whenever sub-tidal seagrass meadows were seen. The patchy nature of the meadows makes each of them an important feeding ground if dugong and turtles are travelling along the coast.

Threats to seagrass meadows in this region are largely climate related with losses reported after cyclones (Poiner et al. 1989). There is potential for sea level rise, thermal damage to seagrasses, and algae blooms smothering meadows if global climate change predictions become real. Isolated port developments at Weipa, Karumba, McArthur River

and Thursday Island are relatively small in size, well managed and unlikely to have any major impact on seagrasses (Coles et al. 2004).

The present survey provides a valuable snapshot of seagrasses in intertidal waters. Comparison with previous surveys and the smaller scale long term spatial analysis from Karumba and Weipa point to seasonal and long-term (yearly and longer) cycles of change in distribution and extent. These structural, physical changes will interact with more localised and patchy ecological processes such as herbivory and plant sediment interactions. Together these will lead to highly variable seagrass meadows and variations in the biomass of associated flora and fauna. We do not know the outer limits of these natural changes nor can we even guess at the thresholds of change past which these systems could be lost or permanently changed. There are Global Monitoring Programs for seagrass in place in the western Pacific targeted at monitoring the long-term changes of reef platform and island seagrasses ([www.SeagrassNet.org](http://www.SeagrassNet.org) & [www.seagrasswatch.org](http://www.seagrasswatch.org)). There are no similar programs for the inshore tropical seagrass habitats that are mapped at this scale in the present survey. These seagrasses are at least as important as those in the Pacific and from a research perspective, and from the perspective of being able to give the best advice for management, consideration of a longer term monitoring/mapping program would be desirable.

### **Discarded Fishing Gear**

The distribution of discarded fishing gear was clumped with most occurring in two locations – the north western Gulf and just to the north of Aurukun. The majority of discarded fishing gear sighted was net pieces (1 – 10 metres in length), not intact fishing gear. Much of the net was partially buried and many net pieces would not be visible from a helicopter because of this. Only stranded net would be observed during a seagrass survey.

Despite these limitations a surprising amount of net pieces were recorded, the type of net noted, and the location position fixed by GPS. The distribution of discarded fishing gear provided in Map 5 however is best considered as a guide to the location and the extent of the discard problem.

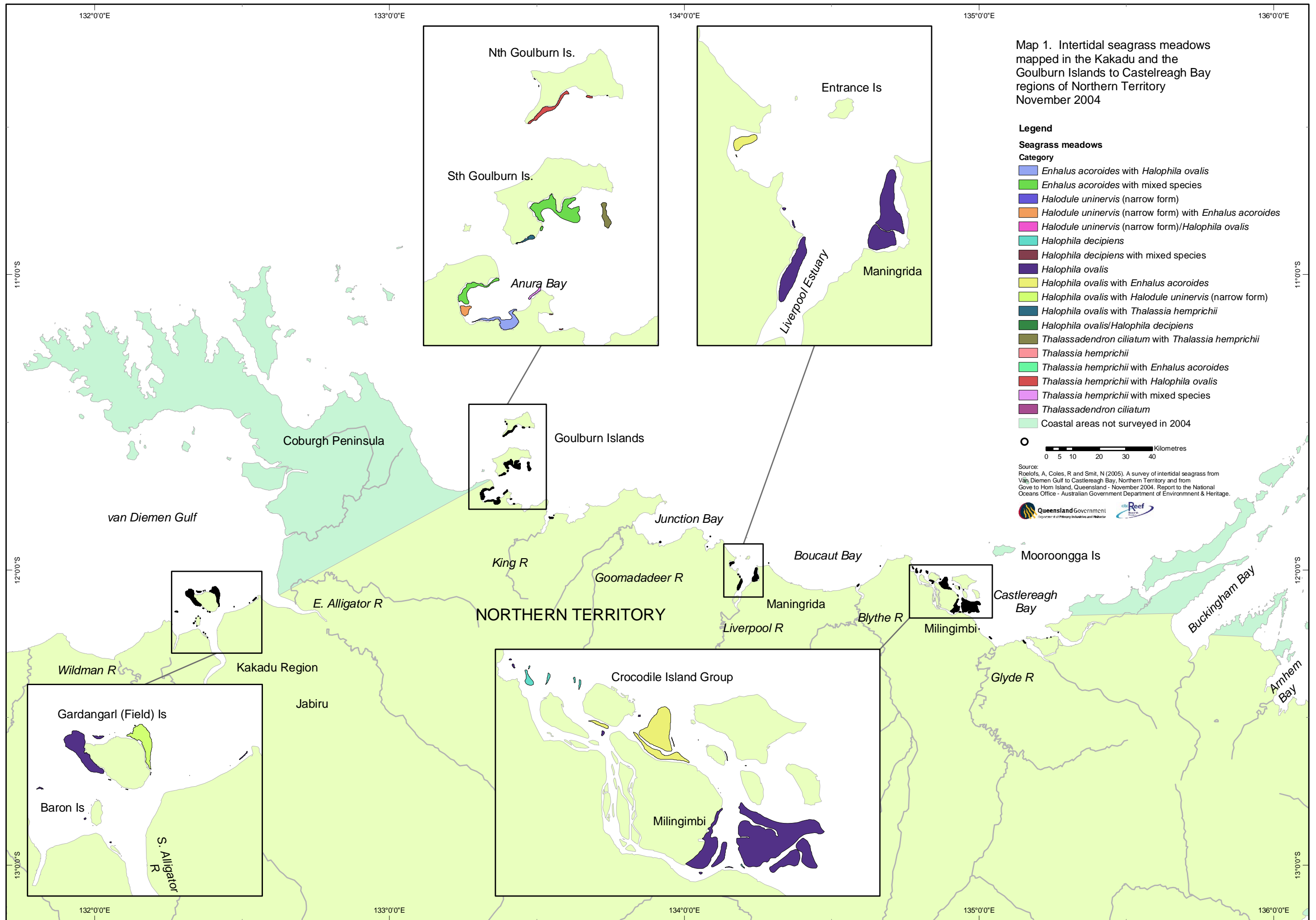
Location of crab traps/pots were also noted. These were particularly common in the southwest Gulf. Many were not marked with float lines (required by Fisheries Regulations) and most did not appear to be maintained or serviced. Our survey strategy emphasised intertidal areas and it is likely that the numbers of abandoned crab traps was underestimated because of this. Many of the traps seen were in a condition where it would be expected they could continue to fish. It would be highly desirable to collect and remove these traps.

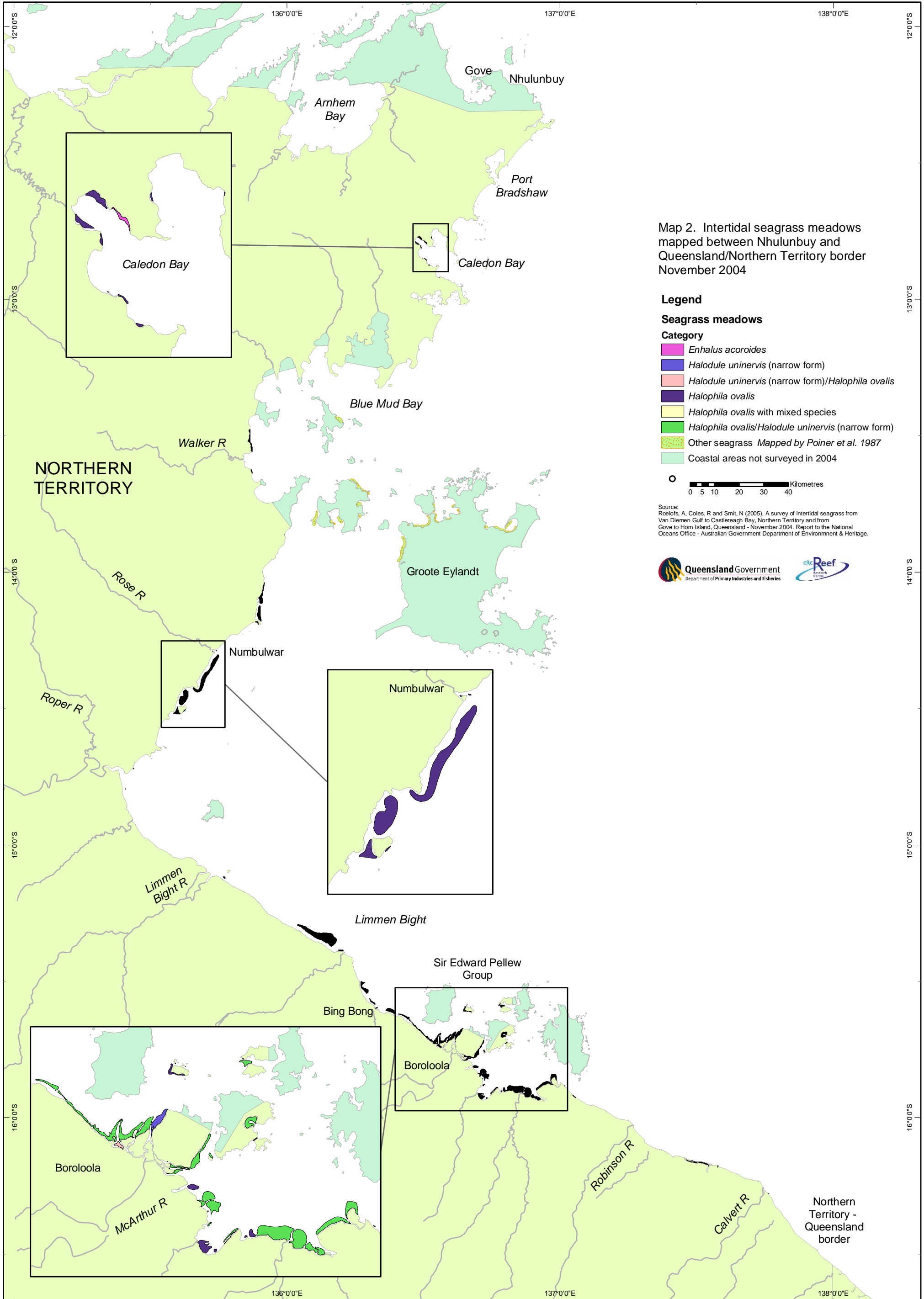


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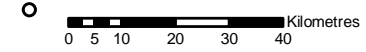
Map 2. Intertidal seagrass meadows mapped between Nhulunbuy and Queensland/Northern Territory border November 2004

**Legend**

**Seagrass meadows**

**Category**

- Enhalus acoroides*
- Halodule uninervis* (narrow form)
- Halodule uninervis* (narrow form)/*Halophila ovalis*
- Halophila ovalis*
- Halophila ovalis* with mixed species
- Halophila ovalis*/*Halodule uninervis* (narrow form)
- Other seagrass Mapped by Poiner et al. 1987
- Coastal areas not surveyed in 2004



Source: Roelofs, A. Coles, R. and Smit, N. (2005). A survey of intertidal seagrass from Van Diemen Gulf to Castlereagh Bay, Northern Territory and from Gove to Horn Island, Queensland - November 2004. Report to the National Oceans Office - Australian Government Department of Environment & Heritage.



12°00'S  
13°00'S  
14°00'S  
15°00'S  
16°00'S

12°00'S  
13°00'S  
14°00'S  
15°00'S  
16°00'S

136°00'E 137°00'E 138°00'E

136°00'E 137°00'E 138°00'E



Map 3. Intertidal seagrass meadows mapped between Queensland/Northern Territory border and Bamaga  
November 2004

Source: Roelofs, A. Coles, R and Smit, N (2005). A survey of intertidal seagrass from Van Diemen Gulf to Casterreagh Bay, Northern Territory and from Gove to Horn Island, Queensland - November 2004. Report to the National Oceans Office - Australian Government Department of Environment & Heritage.



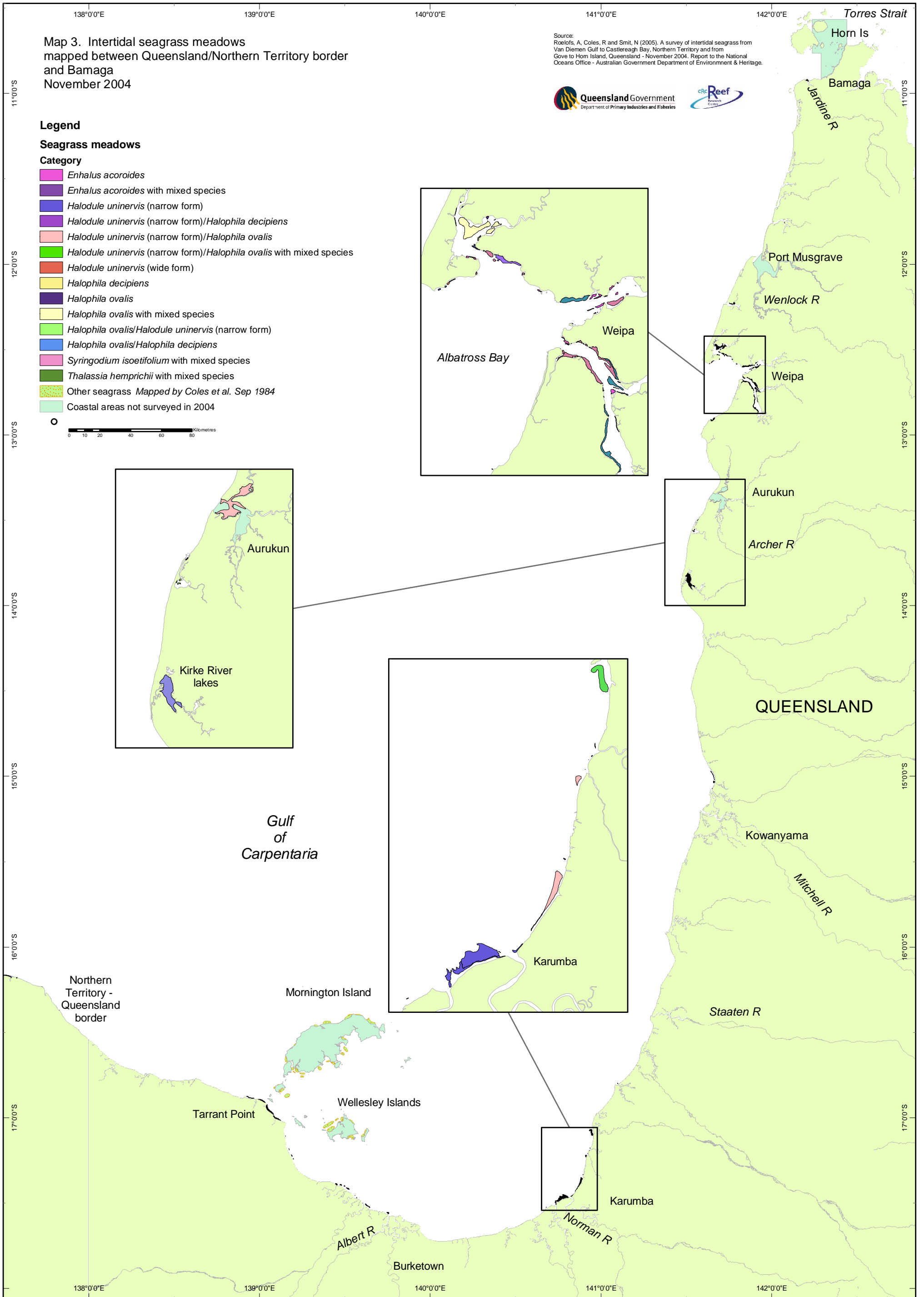
**Legend**

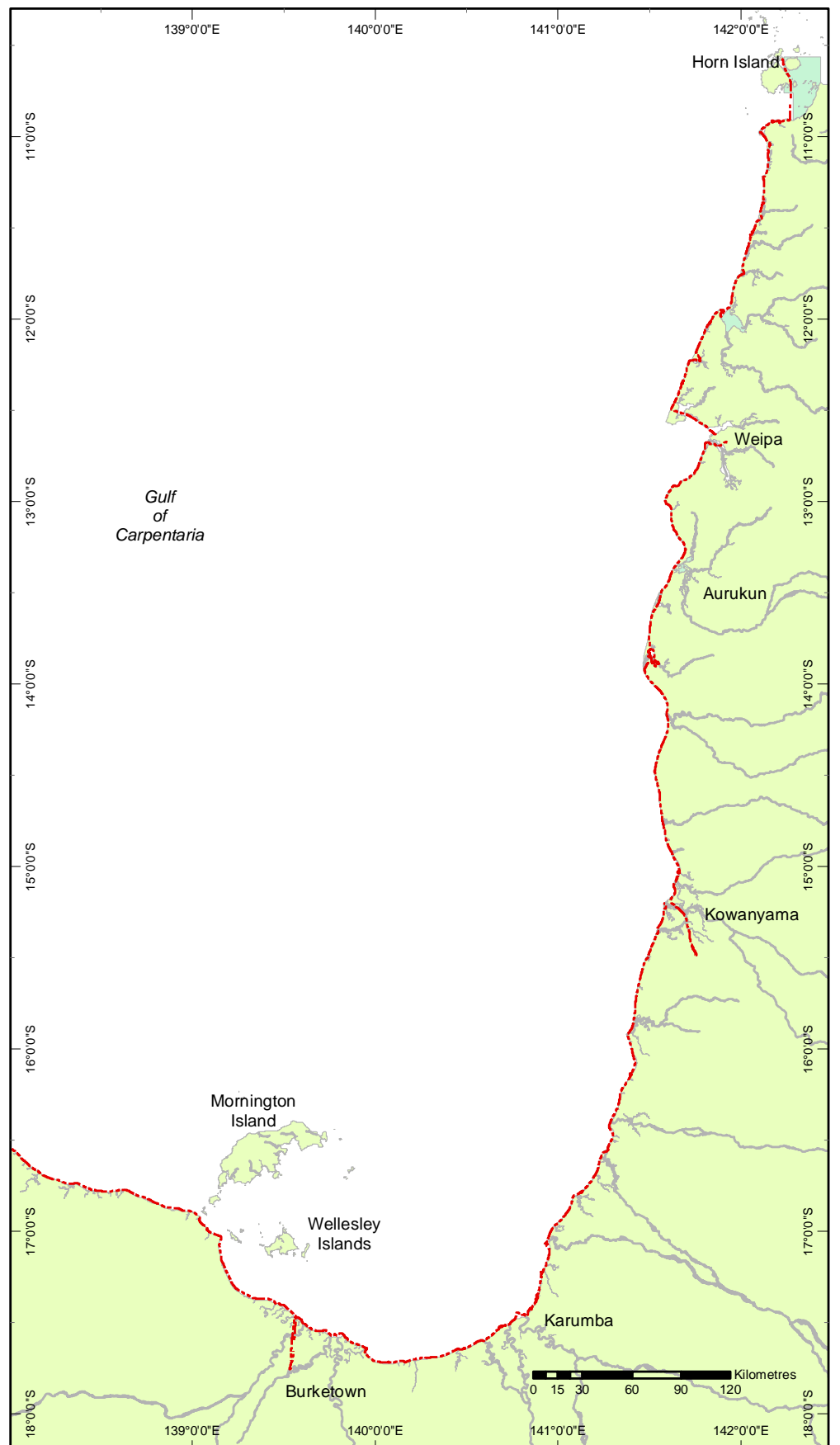
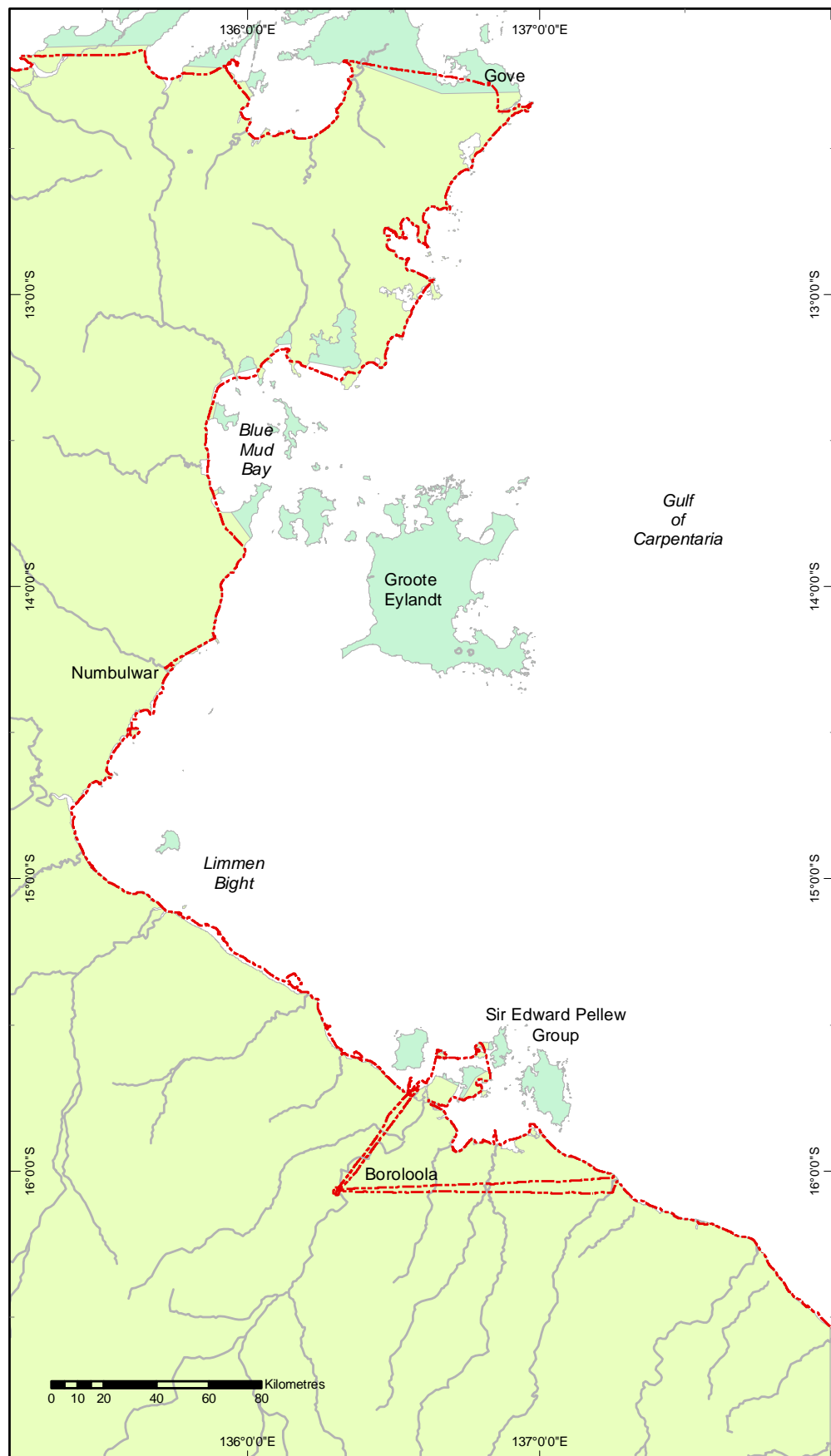
**Seagrass meadows**

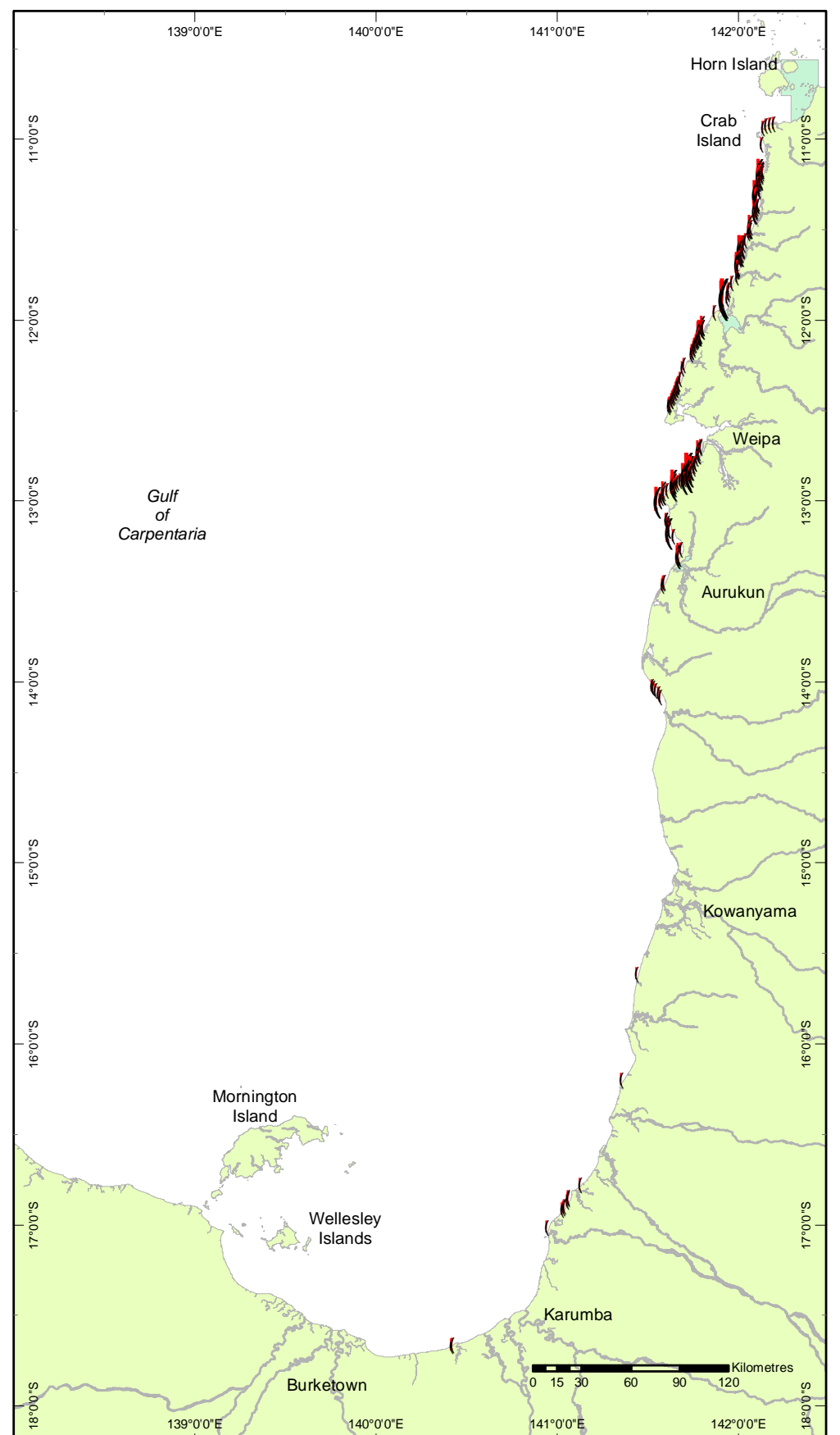
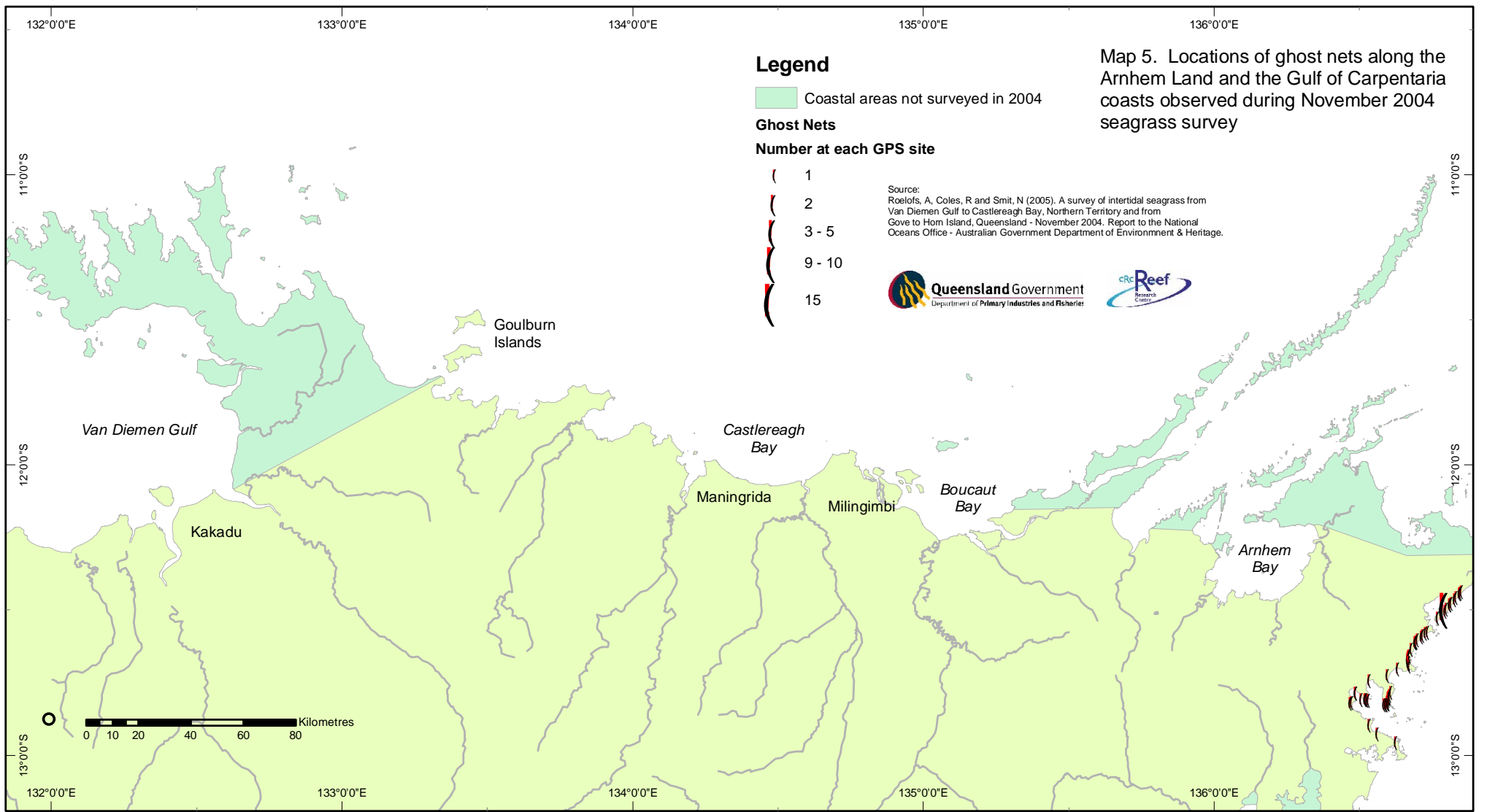
**Category**

- Enhalus acoroides*
- Enhalus acoroides* with mixed species
- Halodule uninervis* (narrow form)
- Halodule uninervis* (narrow form)/*Halophila decipiens*
- Halodule uninervis* (narrow form)/*Halophila ovalis*
- Halodule uninervis* (narrow form)/*Halophila ovalis* with mixed species
- Halodule uninervis* (wide form)
- Halophila decipiens*
- Halophila ovalis*
- Halophila ovalis* with mixed species
- Halophila ovalis*/*Halodule uninervis* (narrow form)
- Halophila ovalis*/*Halophila decipiens*
- Syringodium isoetifolium* with mixed species
- Thalassia hemprichii* with mixed species
- Other seagrass Mapped by Coles et al. Sep 1984
- Coastal areas not surveyed in 2004

0 10 20 40 60 80 Kilometres



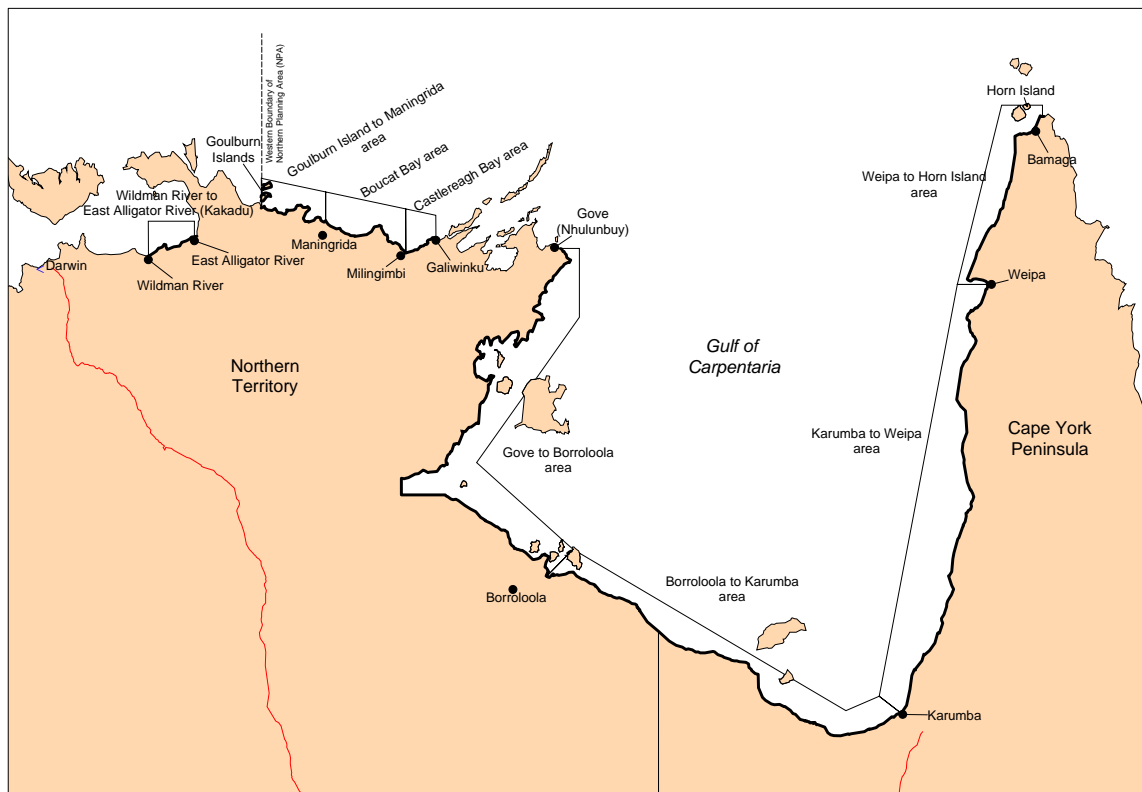




## APPENDIX 1

### Notice of helicopter seagrass surveys across the northern Australian coastline

A seagrass survey will be done by helicopter between the Van Diemen Gulf in the Northern Territory, around the Gulf of Carpentaria, and ending in the Torres Strait between 13 and 20 November 2004. Researchers will be working from the helicopter to identify and map where seagrass beds are across the northern Australian coastline. The survey area is shown in the map below.



The groups who will be doing this survey are the National Oceans Office, the Department of Infrastructure, Planning and Environment from the Northern Territory, and the Queensland Department of Primary Industry and Fisheries.

The helicopter will fly close to the shoreline and sometimes close to the ground so that the researchers can record the seagrasses. The helicopter will land to refuel at communities where permissions and permits will be obtained prior to the survey. The helicopter may also make very occasional and brief landings to make positive seagrass identification. The timetable where the researchers will be doing the survey and where the helicopter will be landing is shown in the table on the next page.

The maps of seagrass beds and information about seagrasses that comes from this survey will be made available to anybody who is interested.

<b>Dates (2004)</b>	<b>Survey area</b>
13 – 17 Nov	13 Nov – Kakadu and Goulburn Is to Maningrida (overnight at Maningrida) 14 Nov – Boucaut Bay (overnight at Maningrida) 15 Nov – Boucaut to Castlereagh Bay (overnight at Milinginbi) 16 Nov – Castlereagh Bay (overnight at Nhulunbuy) 17 Nov – Nhulunbuy to Borroloola (overnight at Boroloola)
18 – 20 Nov	18 Nov – Borroloola to Karumba (overnight at Karumba) 19 Nov – Karumba to Weipa (overnight at Weipa) 20 Nov – Weipa to Horn Island (overnight at Horn Island)

If you would like more about the seagrass survey or would like to get copies of the information that comes from the survey, please contact the following people:

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